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Book review

Geodynamics, 3rd edn
Turcotte, D.L. and Schubert, G., eds, *Cambridge University Press*, 2014, ISBN: 9780521186230, Paperback, 636 pp.

Turcotte and Schubert's 'Geodynamics' book has been essential reading for generations of Earth scientists. Ever since the appearance of the first edition in 1982, lecturers in geodynamics worldwide use the book as reading material, and the large number of citations in the scientific literature illustrates that the book is also heavily used by researchers. I still remember well the excitement when I bought the 2nd edition when it became available a little more than a decade ago: after years of taking out well-worn copies from the University library, I suddenly was the proud owner of my own copy (which by now is equally well worn). Over the years, the book has helped me to understand and teach many different aspects of geodynamics, and it continues to do so.

Now the 3rd edition lies in front of me. A first leafing-through shows that most of the familiar contents is much the same. Apart from being a bit bulkier than the previous edition, the structure and basic contents of first 10 chapters remained mostly unchanged, with the same wide range of geodynamic topics presented in the same convenient, familiar way: Chapter 1 sets the scene, describes the plate-tectonic framework, and sets Earth in the context of the other terrestrial bodies in our Solar system. Chapter 2 relates pressure, stress and strain, and Chapter 3 builds on from there by applying the flexure of an elastic beam to a variety of lithospheric elasticity scenarios, such as seamount loading and plate bending into a subduction zone. Heat transfer, heat flow, geotherms, and radiogenic heating are discussed in Chapter 4. The Earth's gravity field is explained in Chapter 5, with application on both global and local scale. Next is fluid dynamics in Chapter 6, where simple 1-D and 2-D scenarios of the general Navier–Stokes equations are applied to an impressive range of geodynamic problems on all scales. Viscous and visco-elastic strength and deformation of rocks are discussed in Chapter 7, while brittle strength and faulting is the topic of Chapter 8. Chapter 9 is on porous media flow, with applications to groundwater flow and magma transport. Chapter 10 introduces geochemical reservoirs in the Earth, and how radiogenic isotope studies provide important constraints on the Earth's evolution.

Each topic in the book builds on from previously discussed ones, or at least so within each chapter. This successful learning approach enables the student to build an understanding of more complex concepts by referring back to simpler, more familiar concepts discussed earlier. This approach can be a bit frustrating for those who try to find a quick answer (since they'll find themselves continuously working back towards the start of a chapter), but is an excellent way to obtain a good understanding and insight. Throughout these chapters, an extensive set of problems provide the reader with opportunities to test their understanding and ability to apply the theory to practical scenarios. These exercises are aimed at undergraduate level, and the required level is science background is kept to a minimum: all the physical, mathematical, and geological concepts are carefully explained.

This third edition has several exciting additions. A clear 'In this Chapter' overview at the start of each chapter, and a 'Summary' at the end help the reader to navigate through this book. Also the layout is clearer: exercises are clearly identifiable by their grey boxes. But the main addition to this 3rd edition is a wealth of online resources in the form of Matlab codes and numerical solutions to problems, and the availability (to lecturers) of all the graphics in the book as JPEG or Powerpoint files.

The extensive set of Problems for students to work through has mostly remained unchanged, but some of them have now an 'M' symbol, indicating that Appendix D provides Matlab scripts to support answers to some of the Problems in the book. In many cases, this is useful, although sometimes, a one-line equation could have replaced a much longer Matlab code. The printed version of Appendix D may be useful, but is not really necessary, since it is available in an easy copy-and-paste electronic form online.

Chapters 11 and 12 are new, and introduce and describe numerical solutions to certain geodynamic problems. In order to keep the book 'self-contained', Chapter 11 provides an introduction into numerical problem solving, including an elaborate (but basic) introduction to Matlab and the concept of numerical finite difference methods. On the one hand, this does perhaps go a bit beyond the scope of the book, in my view, and space would be better used by providing more numerical solutions to the many geodynamic concepts in the book. But on the other hand, it provides the reader with almost all the basic ingredients to calculate numerical solutions to geodynamic problems if analytical solutions are not available.

Chapter 12 numerically solves a range of geodynamic problems from Chapters 3 to 8 (such as elastic plate bending, thermal diffusion, gravity and topography problems, thermal convection, and faulting), and demonstrates how numerical approaches can be useful in a variety of ways. Some examples illustrate how to simply calculate and visualize complex analytical solutions, while others solve the derived differential equations from previous chapters using one of the many sophisticated Matlab toolboxes or a finite difference method. Most examples nicely build on from the introduction in Chapter 11, although some of the presented codes require more advanced knowledge of Matlab tools and aspects of numerical modelling.

The third edition of 'Geodynamics' has all the popular contents of its predecessors and will continue to be an invaluable companion for every geodynamicist. The newly added numerical aspects will provide hands-on opportunities that will give an exciting new dimension to studying geodynamics for all students. For decades, 'Geodynamics' has firmly been the most essential textbook for those studying or teaching mantle dynamics, plate tectonics, and lithosphere dynamics. And with this new edition, this classic textbook is likely to maintain its leading position.

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